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Exploring Command and Control Concepts for an Integrated Effect Coordination Cell using an Enhanced Tabletop Experimentation Approach

Report on the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX)

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Defence R&D Canada – Ottawa

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Abstract

The first exploratory experiment of the Joint Fire Support (JFS) Technology Demonstration Project (TDP), namely the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX), was conducted by the Canadian Forces Experimentation Center (CFEC) Effective Engagement Team (EET) and JFS TDP in the Joint Concept Laboratory and Training Center (JCLTC) located in CFEC, from 14^{th} to 18^{th} May 2007. The main objective of this experiment was to explore various Integrated Effects Coordination Cell (IECC) manning, process flow and control models in order to facilitate the identification of an appropriate model that best suits the requirements of providing optimal Integrated Effects (IE).

In addition to the overall objective the scientific staff also gained valuable insight into:

- information requirements for each option;
- situational awareness requirements for each option; and
- areas best suited for automation.

This report documents the approach used to conduct this experiment and captures the findings and lessons learned.

Résumé

La première expérience exploratoire du PDT de STI, l’Expérience exploratoire sur les cellules de coordination des effets intégrés (EECCEI), a été menée par l’Équipe d’Engagement Efficace (EEE) du Centre d'expérimentation des Forces canadiennes (CECF) et du PDT de STI dans le Laboratoire et centre d’instructions de concepts interarmées (LCICI) situé au CECF, du 14 au 18 mai 2007. L’objectif principal de cette expérience était d’explorer différents modèles de contrôle, de déroulement des opérations et de dotation en personnel d’une Cellule de coordination des effets intégrés (CCEI) afin de faciliter l’identification d’un modèle approprié qui permet le mieux de donner des effets intégrés (EI) optimaux.

En plus de l’objectif général, le personnel scientifique a également accumulé des connaissances précieuses sur :

- les exigences en matière d’information pour chaque option;
- les exigences en matière de connaissance de la situation pour chaque option;
- les domaines qui conviennent le mieux à l’automatisation.

Dans ce rapport, on documente l’approche utilisée pour mener l’IECCEX et on saisit les constatations et les leçons apprises.

Executive summary

Exploring Command and Control Concepts for an Integrated Effect Coordination Cell using an Enhanced Tapbletop Experimentation Approach : *Report on the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX)*

Sylvia Lam; Wally Woodward; DRDC Ottawa TM 2007-286; Defence R&D Canada – Ottawa; December 2007.

Introduction or background: The first exploratory experiment of the Joint Fire Support (JFS) Technology Demonstration Project (TDP), named the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX) was conducted by the Canadian Forces Experimentation Center (CFEC) Effective Engagement Team (EET) and JFS TDP in the Joint Concept Laboratory and Training Center (JCLTC) located in CFEC, from 14th to 18th May 2007. The main objective of this experiment was to explore various Integrated Effects Coordination Cell (IECC) manning, process flow and control models in order to facilitate the identification of an appropriate model that best suits the requirements of providing optimal Integrated Effects (IE).

Results: For each of the four command and control models explored, while unique in the way a request was planned and executed, there are common domains that are critical to the success of an IECC organization. These commonalities are:

- **Parallel Processing and Collaboration -** It was observed that the IECC team was able to plan a delivery of effect more efficiently when the planning tasks were processed in parallel rather than in sequence. However, standard operating procedures for parallel processing of calls for effects must be developed so that duplicate planning and re-planning for an effect request could be avoided. The increase in parallel processing also leads to a stronger need for the ability to synchronize the activities. In the two centralized models, synchronization was enforced by the commander and/or the IECC officer. In the two decentralized models, the IECC team developed some impromptus approach to achieve *self-synchronize* with varying degrees of success.
- **Situation Awareness -** The commander and team must at all time keep a current mental awareness of the battlespace, the available resources and the battle rhythm. While in the “IECCEX net-centric environment”, all the workstations were fed with identical information, good SA was not always achievable due to task allocations. The descentralized C2 models showed that the commander can achieved better SA than in the centralized models.
- **Allocation of Tasks and Authority -** In order to ensure the timely sharing of information and optimal delivery of effects it is imperative that the workload is shared among the team. This implies that the appropriate training, the needed authority and responsibilities must be clarified to enable effective processing. This is particularly important as we move towards the spectrum of decentralization as observed in the four C2 models.

In addition, while the IECCEX focused on the planning activities (selection of effectors and delivery system) versus the execution (actual delivery of effect), it was evident that planning and

execution were two distinct functions that influence the final delivery of effects. It is imperative that both the planning and execution functions, at both the staff and command level, be examined when exploring the optimal process flow and control model for the optimal delivery of effects.

Significance: This exploratory experiment represents the first step towards the development of an efficient and effective JFS model to deal with changes in the nature of war. This experiment enabled the scientists to exchange with the CF operators effectively in a mock-up environment and identified critical areas that the JFS scientists must address in subsequent concept development and experimentation activities.

Future plans: JFS TDP will continue to work closely with the CFEC EET to use simulation and experimentation techniques to develop the future JFS model.

Sommaire

Exploring Command and Control Concepts for an Integrated Effect Coordination Cell using an Enhanced Tapbletop Experimentation Approach : *Report on the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX)*

Sylvia Lam; Wally Woodward; DRDC Ottawa TM 2007-286; R & D pour la défense Canada – Ottawa ; Decembre 2007.

Introduction ou renseignements généraux : La première expérience exploratoire du PDT de STI, l'Expérience exploratoire sur les cellules de coordination des effets intégrés (EECCEI), a été menée par l'Équipe d'Engagement Efficace (EEE) du Centre d'expérimentation des Forces canadiennes (CECF) et du PDT de STI dans le Laboratoire et centre d'instructions de concepts interarmées (LCICI) situé au CECF, du 14 au 18 mai 2007. L'objectif principal de cette expérience était d'explorer différents modèles de contrôle, de déroulement des opérations et de dotation en personnel d'une Cellule de coordination des effets intégrés (CCEI) afin de faciliter l'identification d'un modèle approprié qui permet le mieux de donner des effets intégrés (EI) optimaux.

Résultats : Les modèles de commandement et de contrôle explorés au cours de l'EECCEI avaient tous une façon unique de planifier et d'exécuter une demande, mais ils comportaient tous des domaines communs critiques au succès d'une organisation de CCEI. Ces domaines communs étaient :

- **le traitement en parallèle et la collaboration –** On a observé que l'équipe de CCEI a pu planifier une production d'effet plus efficacement lorsque les tâches de planification on été traitées en parallèle plutôt qu'en série. Cependant, il faut développer des instructions permanentes d'opération pour le traitement en parallèle des demandes d'effets pour éviter le dédoublement de la planification et de la re-planification d'un effet. L'accroissement du traitement en parallèle exige aussi une plus grande capacité de synchronisation des activités. Dans les deux modèles centralisés, la synchronisation a été appliquée par le commandant et/ou l'officier de la CCEI. Dans les deux modèles décentralisés, l'équipe de la CCEI a développé des approches impromptues pour créer une *auto-synchronisation* avec différents degrés de réussite.
- **la connaissance de la situation** – Le commandant et l'équipe doivent, en tout temps, conserver une connaissance mentale de l'espace de combat, des ressources disponibles et du rythme du combat. Tous les postes de travail ont reçu des informations identiques dans « l'environnement axé sur le réseau de l'EECCEI », mais il n'a pas toujours été possible d'obtenir une bonne CS comme l'ont démontré les observations faites au cours de l'expérience. Néanmoins, certains modèles C2 permettaient une meilleure CS que d'autres.
- **l'allocation des tâches et de l'autorité** – Pour assurer le partage en temps voulu de l'information et la production optimale des effets, il est impératif que la charge de travail soit partagée par les membres de l'équipe. Cela nécessite la clarification de l'instruction voulue, de l'autorité nécessaire et des responsabilités pour permettre un traitement

efficace. Cela est d'une importance particulière à mesure que nous approchons de la décentralisation, tel qu'observé dans les quatre modèles C2.

De plus, malgré le fait que l'EECCEI portait tout particulièrement sur les activités de planification (sélection des producteurs d'effets et du système de production) par rapport à l'exécution (la production réelle de l'effet), il était évident que la planification et l'exécution étaient deux fonctions distinctes du personnel et du commandement de la CCEI qui ont une incidence sur la production finale des effets. Il est impératif d'examiner les fonctions de planification et d'exécution, au niveau du personnel et du commandement, lorsqu'on explore le modèle optimal de déroulement des opérations et de contrôle pour la production optimale des effets.

Importance : Cette expérience exploratoire représente le premier pas vers le développement d'un modèle de STI efficient et efficace pour s'adapter aux changements dans la nature de la guerre. Cette expérience a permis aux savants d'échanger efficacement avec des opérateurs des FC dans un environnement simulé et d'identifier les secteurs critiques dont les savants du STI doivent tenir compte dans les activités ultérieures de développement de concepts et d'expérimentation.

Plans futurs : Le PDT du STI continuera à collaborer étroitement avec l'EEE du CECF pour utiliser des techniques de simulation et d'expérimentation afin de développer le modèle de STI futur.

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1 Introduction

Joint Fire Support (JFS) is the collective and coordinated use and exploitation of command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) assets, information operations (IO) and direct and indirect fire systems to support operations. It includes lethal and nonlethal, kinetic and nonkinetic actions.

The changing nature of warfare has prompted the need to re-evaluate the current approach to JFS as documented in the Canadian Forces (CF) doctrines, and look for areas of improvement to maintain our superiority in the battlespace. While new technologies introduce possibilities for precise fire delivery and faster information exchange, the nature of conflicts and the battlespace are also becoming more complex. Consequently, the CF must re-evaluate the current JFS system and incorporate new warfighting concepts and technologies to deal with the changes.

The goal of the JFS Technology Demonstration Project (TDP) is to develop a model for a Joint Fires system that provide the commanders with more options with which to respond to the increasing requirement to handle dynamic and time sensitive targets while minimizing the impact upon strategic and preplanned targeting. The overall effect should be to increase the agility and effectiveness of the force. This model must work within a net-centric environment and apply effect-based thinking to operations. The realisation of this model will provide the CF with the capability to operate in a more complex and dynamic environment. Modeling and simulation, as well as experimentation are the main enablers for the realisation of this future JFS model.

The first exploratory experiment of the JFS TDP, the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX) was conducted by the Canadian Forces Experimentation Center (CFEC) Effective Engagement Team (EET) and JFS TDP in the Joint Concept Laboratory and Training Center (JCLTC) located at the CFEC, from 14th to 18th May 2007. This experiment was also supported by the CFEC Joint Experimentation Synthetic Environment (JESE) team; 2 Royal Canadian Horse Artillery (RCHA) Petawawa; Experiment Operational Research Team; Future Forces Synthetic Environment (FFSE) Section at DRDC Ottawa, and Black Coral™.

The main objective of this experiment was to explore various Integrated Effects Coordination Cell (IECC) manning, process flow and control models. This will facilitate the identification of an appropriate model that best suits the requirements for providing optimal Integrated Effects (IE). In addition to the overall objective the scientific staff also gained valuable insight into:

- Information requirements for each option;
- Situational awareness requirements for each option; and
- Areas best suited for automation.

This report documents the approach used to conduct the IECCEX and captures the findings and lessons learned. The organization of this report is as follows: Section 2 describes the context and approach of the experiment, Section 3 describes the infrastructure and tools, Section 4 presents the findings and lessons learned, and Section 5 concludes this report.

2 Conduct of the Experiment

2.1 Context

It's been emphasized in the DND/CF Concept Paper and Roadmap for Network Enabled Operations [1] that in a Network-enabled Operations (NEOps) environment, command and control may face a fundamental change:

"Through a clear understanding of the commander's intent and the operational picture, leaders will be able, and expected, to exercise increased initiative. In doing so, a balance needs to be attained between micromanagement of subordinates and excessive independence from commanders that may be possible through the broad asset visibility achievable through NEOps. The Orders procedure will be reduced, as much of the information required to execute a mission will be readily accessible by subordinate levels beforehand, allowing pre-planning in advance of orders."

Led by this thought, the IECCEX was designed to explore the issues related to command and control in an IECC with respect to manning, control and process flow. It is important to note that the IECCEX did not set out to prove any hypothesis, but was designed to create an enhanced tabletop wargame environment for CF operators and scientists to explore C2 concepts.

The experiment was conducted over a five-day period. The first day was dedicated to allow participants to familiarize themselves with the environment and for tools testing. The actual wargaming were conducted in the following three days. The last day of the experiment was intended for briefing and demonstration to senior management.

2.2 An Enhanced Tabletop Experiment Approach

The IECCEX enhanced tabletop wargaming environment made use of existing computer network on site to construct a network-enabled environment. The Effective Engagement Team incorporated readily customizable software tools for visualization, collaboration and data management. A description of the environment and the tools is provided in Section 3.

Before the start of each wargame, the participants were first briefed on the C2 model to be explored and its implication on the flow of command and control within the IECC. The participants were then assigned to specific roles and tasks according to the targeting process. Each participant was provided with a computer workstation to perform his tasks and to interact with others.

Each wargame consisted of two parts: the first part was a dry-run; allowing the participants to try out specific command structure and control process flow they were instructed to follow. Once the participants were comfortable with the concept and the process, the wargaming tools were reset and the full run began. The run continued until enough data were collected. On average, a dry run took 15 to 20 minutes and a full run lasted roughly 45 minutes to 1 hour 15 minutes.

After each wargame, all participants were gathered in a conference room for debriefing and round table discussion on any thoughts related to the C2 models, the potential applications, and on possible improvements to challenges encountered. Each participant was asked to complete a questionnaire before the conclusion of the discussion session.

2.3 Scenario Development and Assumptions

A framework of the Chief of Force Development (CFD) "Failed State" scenario was used to set the scene for IECCEX. Friendly and enemy Order of Battle (ORBAT)/forces, modest Rules Of Engagement (ROE) and Commander's intent were developed to support the scenario and to provide role players with sufficient infrastructure to explore the various C2 models. These supporting information can be found in Annex A.

To reduce the complexity, the following assumptions have been made for the IECCEX:

- Scenario takes place in a net-centric environment
- All personnel have the same level of situation awareness of the complete battlespace
- There is no enemy electronic ORBAT (Jamming)
- This experiment we will only examine the people and process portions of an IECC
- Technology requirements will not be the focus of discussion

2.4 C2 Models Explored

The spectrum of command and control models span between the most centralized (micromanagement) and the completely decentralized (excessive independence from commanders). For the purpose of IECCEX, the scientific staff has selected four representative models to explore. These models were not definitive options for the future IECC concept, but simply served as a starting point to identifying the ideal solution.

The four models used in IECCEX were referred to as:

- Fully Centralized Control;
- Partially Centralized Control;
- Decentralized Control with Specialists; and
- Decentralized Control with "All Capable" entities.

Model 1 : Fully Centralized Control: In this model, the commander was intended to be a *micromanager* who was involved in every major step of the Targeting Process. He would issue direct and specific orders to subordinates when required. He also expected subordinates to report to him directly.

During the wargame, the commander would first review the incoming request for fire, assess the situation and determine which service (Land, Air, Maritime) should respond to the request. He would then issue direct order to the component command to request a proposal of asset that best fit the request. If this component command did not have the right asset, he would then task another component until he has exhausted his options, which would render the request unfilled.

Model 2: Partially Centralized Control: In this model, the commander had a reduced level of management, allowing some decision-making be passed down to subordinates.

During the wargame, the commander reviewed incoming fire requests and determined their priority in the process. He would then issue a tasking to all the subordinates and instruct them to work on one specific fire folder at the same time. All component commands would evaluate the effect requested and propose a suitable asset. The commander would choose among the proposed assets and authorize the delivery.

Model 3 : Decentralized Control with Specialists: Moving towards decentralization in the C2 spectrum, this model reduced the responsibilities of the commander by allowing all subordinates to process fire request according to their abilities. The commander was aware of the activities of his members but did not issue routine tasking. It was assumed that members had common situation awareness and that they were capable of self-synchronizing.

During the wargame, the commander's responsibilities include the initial evaluation of the fire request and create fire folder for dissemination to all subordinates. No direct tasking was involved here. Based on their judgment on priority, all members would decide individually which fire folder to process. All issues related to ROE or proposed assets were noted on each fire folder and were accessible to all members once it was updated. While each fire folder must be processed by each member of the IECC, it did not have to be done sequentially. Members signed the folder after they have processed their task, and when all the signatures were completed, the commander would review the fire folder and decide on the action (order to deliver effect or declare request unfilled).

Model 4 : Decentralized Control with "All-capable" Entities: Situated on the other extreme of the C2 spectrum, this model did not have a tradition commander in place but was replaced by a number of "all-capable" entities that were trained to handle all tasks throughout the Targeting Process. Since all entities had access to all information and had same level of SA, the entities were expected to collaborate and self-synchronize to generate optimal results.

In the wargame, when fire request arrived at the IECC, it was kept in a queue and was broadcasted to all entities. Each entity would evaluate their ability to process this request. If one entity decided to process a request, this request would be marked and locked on the queue so that no other entities could process it. Nonetheless, the information content was accessible to all others. The entity would be responsible for the request till the end (including authorization of asset to deliver effect, or determining request could not be filled). In this model, entities were competing for limited resources and were exptected to self-synchronize to generate the best outcome.

2.5 Analysis and Data Collection

Data was collected through a series of:

- Chronological records of each serial;
- Facilitated de-briefs after each run;
- Questionnaires;
- Observations noted by scientists and engineers; and
- After Action Reports.

The findings based on information collected are presented in Section 4.

3 Infrastructure and Tools

IECCEX made use of an enhanced tabletop experiment to facilitate the exploration of possible C2 models for IECC. The Effective Engagement Team in CFEC created a collaborative net-enabled environment to maximize the “touch-and-feel” of the concept of an IECC. The infrastructure and the tools used in the IECCEX, including the network connection of various computer terminals, basic data management software (Microsoft office™), and visualization tool, Black Coral™ required reasonable level of effort to customized for this trial.

3.1 Physical Layout

In this experiment, the IECC was made up of the Integrated Task Force Commander (ITFC), who was supported by his officer (IECC-O), the Air Component Command, Maritime Component Command, Land Component Command, and the legal advisor / ROE representative. Despite their specific functions, all their workstations were identical and were networked together. Figure 1 illustrates the physical layout of the workstations of various IECC roles as well as the experiment’s support staff. Note that the “white cells” workstations were used by experiment facilitator to inject events into the wargames and manage the data generated by the runs.

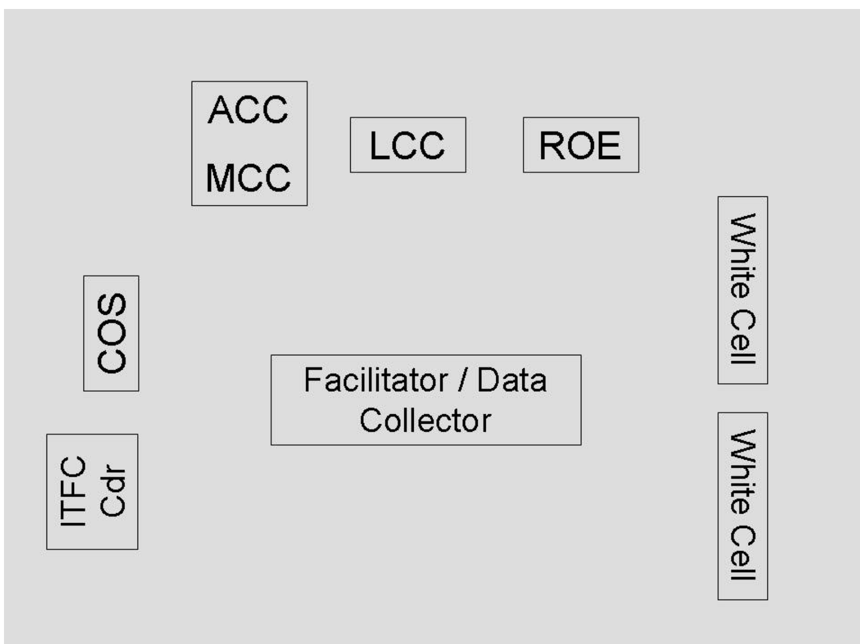

Figure 1 Physical Layout of the Workstations in the Experiment

3.2 Visualization Tool for Situation Awareness

While the scenario was fictional, the experiment made use of existing geographical data in the area of Vancouver, British Columbia, for the purpose of visualization and situation awareness. The experiment battle space was divided into three Areas of Interest (AOIs) (Rural, Urban and Wilderness) and provided role players with a unique set of effects delivery challenges. A visual representation of these AOIs was provided by Black Coral™. Figure 2 is a snapshot of the screen. Note that Black Coral™ has an integrated "Chat" function (as shown on the left panel of the snapshot). This function can be toggled as required. The IECCEX used both Chat and voice as means of communication

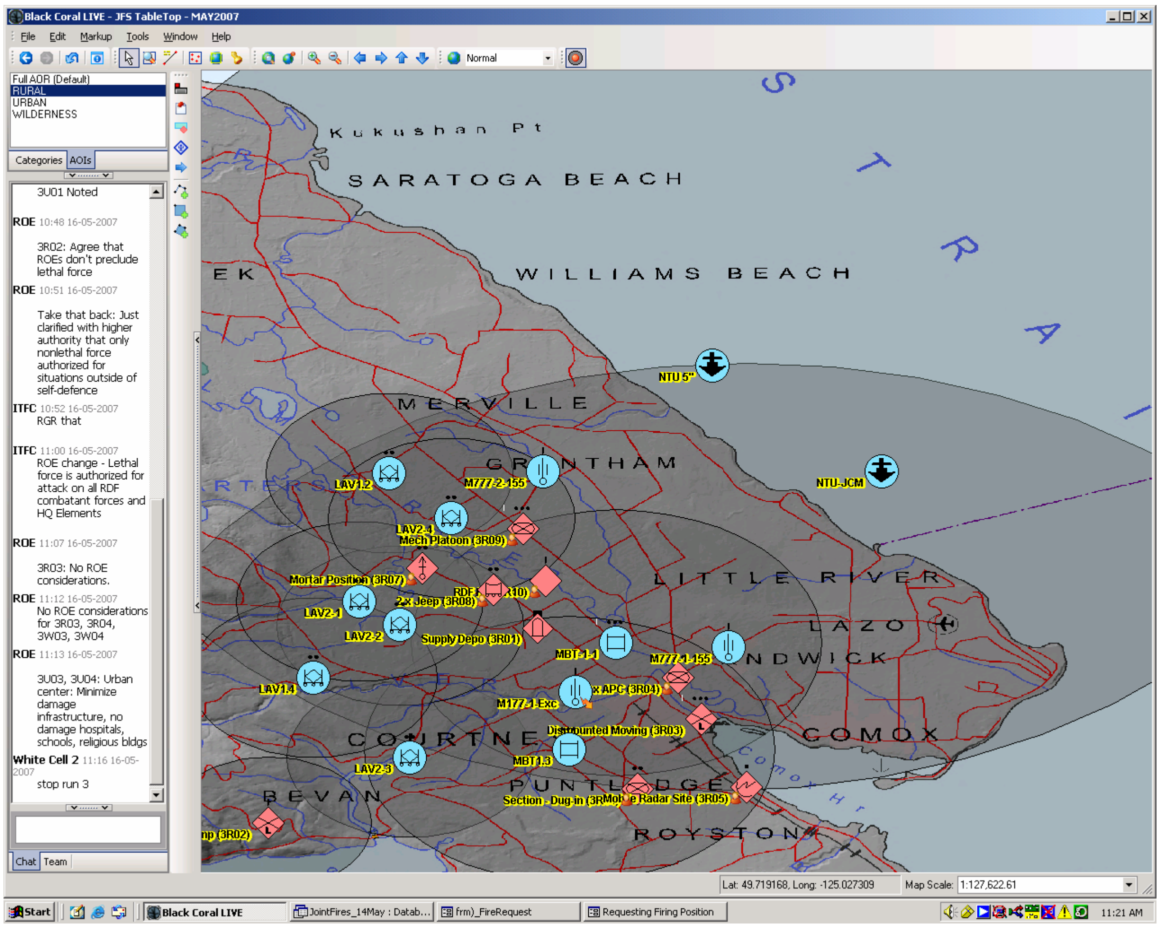

Figure 2 Screen Capture of the Visualization Tool Black Coral™

3.3 Data Management

The data management tools were developed by the Effective Engagement Team using existing Microsoft office™ tools, i.e. ACCESS and EXCEL. These tools were used to generate data needed to drive the experiment, which included requests for effect, weapon status, ROE compliance verification and other information related to the targeting process. The team also created various ACCESS data entry forms as interface to the database. Figure 3 shows a snapshot of the electronic Fire Folder Form that the participants used to process fire request. Participants filled in the blanks according to their roles, and once they have completed their tasks, they would click the corresponding *checkbox* at the bottom of the form to indicate the status. In some of the C2 models evaluated, the commander used these *checkboxes* to determine the processing status of the Fire Folder and decide when he needed to take action to complete the request. Data entered from various runs were captured in the database for future references.

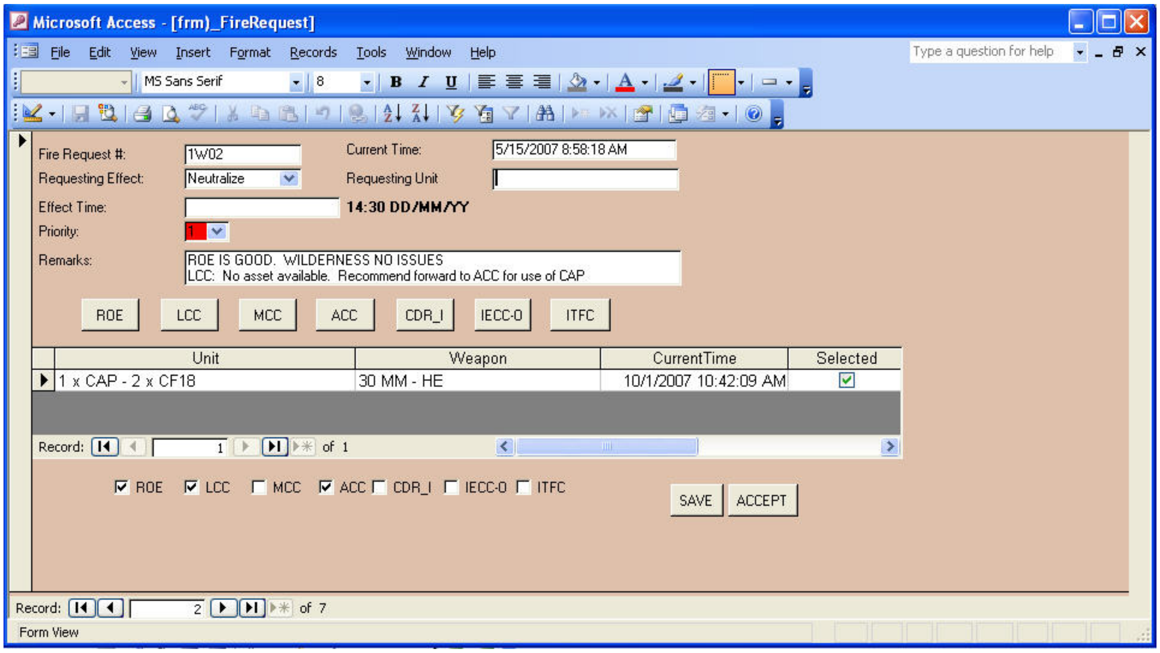

Figure 3 Screen Capture of the Fire Folder Input Screen in EXCEL™

4 Findings and Lessons-Learned

IECCEX has generated good value for the level of effort of an enhanced tabletop experiment. During the IECCEX, eight complete runs (two for each of the four C2 models) were executed. This section summarized the findings. In addition, the lessons-learned from the preparation and execution of the experiment are also documented in this section for future references.

4.1 Findings Related to the C2 Models

For each of the four models explored, while unique in the way a request was planned and executed, there were common domains that are critical to the success of an IECC organization. These commonalities are:

- **Parallel Processing and Collaboration -** It was observed that the IECC team was able to plan a delivery of effect more efficiently when the planning tasks were processed in parallel rather than in sequence. However, standard operating procedures for parallel processing of calls for effects must be developed so that duplicate planning and re-planning for an effect request could be avoided. The increase in parallel processing also leads to a stronger need for the ability to synchronize the activities. In the two centralized models, synchronization was enforced by the commander and/or the IECC officer. In the two decentralized models, the IECC team developed some impromptus approach to achieve *self-synchronize* with varying degrees of success.
- **Situation Awareness -** The commander and team must at all time keep a current mental awareness of the battlespace, the available resources and the battle rhythm. While in the "IECCEX net-centric environment", all the workstations were fed with identical information, good SA was not always achievable due to task allocations. The descentralized C2 models showed that the commander can achieved better SA than in the centralized models.
- **Allocation of Tasks and Authority -** In order to ensure the timely sharing of information and optimal delivery of effects it is imperative that the workload is shared among the team. This implies that the appropriate training, the needed authority and responsibilities must be clarified to enable effective processing. This is particularly important as we move towards the spectrum of decentralization as observed in the four C2 models.

In addition, while the IECCEX focused on the planning activities (selection of effectors and delivery system) versus the execution (actual delivery of effect), it was evident that planning and execution were two distinct IECC functions that influence the final delivery of effects. It is imperative that both the planning and execution functions, at both the staff and command levels, be examined when exploring the optimal process flow and control model for the optimal delivery of effects.

The following paragraphs capture the observations pertaining to each C2 model.

Model 1 : Fully Centralized Control Model

- **Parallel Task Processing and Collaboration –** In this model, all fire folders were processed sequentially and the process flow was controlled by the commander. This model provided an orderly approach to process a request, but lacked the flexibility to make full use of the available human resources.
- **Situation Awareness -** Both the commander and his officer failed to maintain sufficient SA throughout the session because they were overwhelmed by micromanagement. Other team members were able to maintain good SA but their contribution to the targeting process was limited.
- **Allocation of Tasks and Authority** – The imbalance between tasks and authority allocation has let to the commander being overwhelmed, and the subordinates were on light duties waiting for specific tasking from the commander.

Figure 4 is a simplified operational node connectivity description (Operational View 2 in DoDAF). Note that the goal of this figure is to highlight the main information exchange pertinent to the C2 model explored. Interactions between other operational nodes, i.e. interactions with the file folder queue or with other team members may have existed but are omitted in this diagram for presentation purpose.

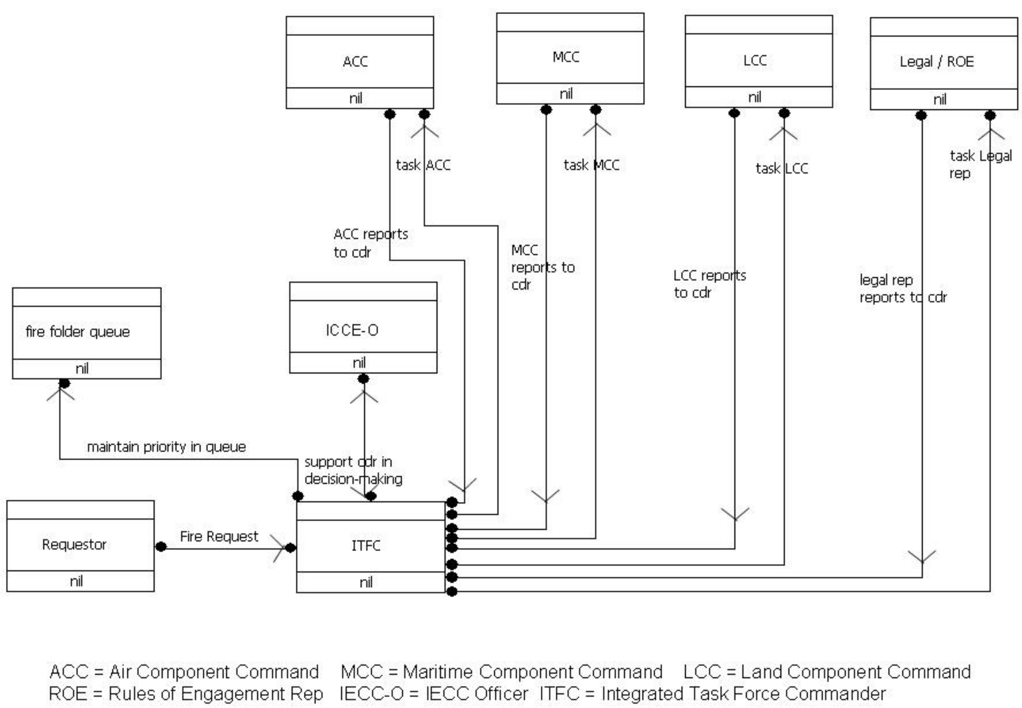

Figure 4 Simplified Operational Nodes Connectivity for Fully Centralized C2 Model

Model 2 : Partly Centralized Control Model

- **Parallel Task Processing and Collaboration –** All fire folders were first evaluated by the commander and then issued to all subordinates for processing (parallel). Each subordinate must check off the file to indicate that they have accomplished their tasks on that file. At this point some degree of synchronization was needed and the IECC officer acted as a scheduler to ensure all fire folders were processed in a timely manner. IECC officer monitored each fire folder status by the checkboxes on the Fire Folder Form (see Section 3.3) and interacted with those who took longer than expected to complete the folder. At times the commander could act on fire folders even though not all the boxes were checked. (E.g. in urgent cases, when the commander felt that the proposed asset from one of the command was sufficient to fulfill the request even the other proposals were not yet available).
- **Situation Awareness -** The commander had slightly better SA as he had reduced his level of management throughout the process. Nonetheless the commander felt he did not enough SA to perform his work to satisfaction. Other team members were able to maintain good SA and they were able to contribute to the targeting process since all component commands were expected to evaluate current SA and propose appropriate asset if available.
- **Allocation of Tasks and Authority –** The more balanced tasking and authority allocation has let to a more efficient process flow. The IECC team felt very comfortable with this model as this was very close to the current mode of operation.

Figure 5 illustrates the main connectivity and information exchange between operational nodes in this model.

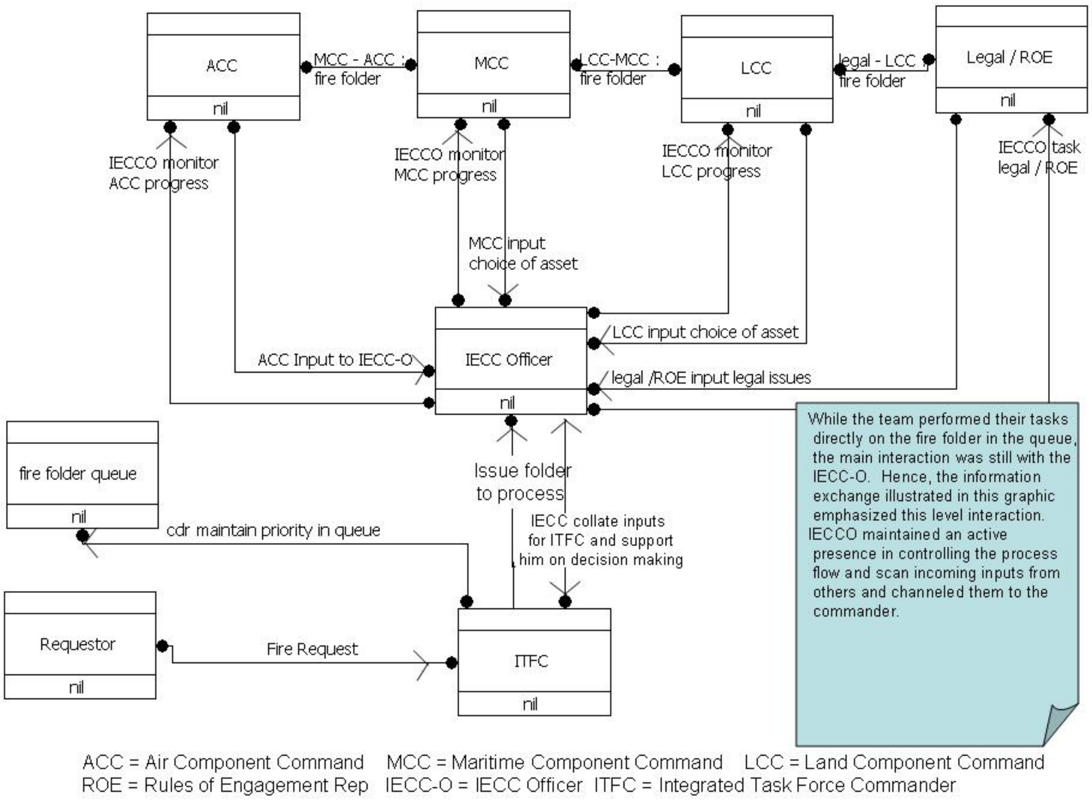

Figure 5 Simplified Operational Nodes Connectivity for Partly Centralized C2 Model

Model 3 : Decentralized Control with Specialists

- **Parallel Task Processing and Collaboration** – In this model parallel processing started from the very beginning as the fire requests were broadcasted to the whole IECC team as they arrived. The subordinates were expected to scan all the fire folders and develop their own processing priority with respect to their understanding of the SA and their ability to process. The role of the commander was reduced to reviewing the fire folders that were completed or were near completion and determine when and whether he needed to take action to choose a proposed asset for delivery, or any other actions required to process the request. The lack of ability to synchronize soon became obvious as many open-ended fire folders were waiting for the last *checkbox* to be filled in. Since all the fire folders were broadcasted at time of arrival, the individual workflow was interrupted from time to time; they had to derive their own tracking mechanism (mostly using pencil and paper) on the folder status they were working on.
- **Situation Awareness** – In this model the commander felt that he was able to maintain a very good level of SA to make sound decisions. Other team members were able to maintain enough SA to perform an adequate job.

- **Allocation of tasks** – While most of the team performed the same tasks and the overall workload was roughly the same; the lack of ability to synchronize with others put pressure on all team members. All of them became potential *chokepoints* in the process. The IECC team felt uncomfortable with this model as there was not enough control in the process flow.

Figure 6 illustrates the main connectivity and information exchange between operational nodes in this model.

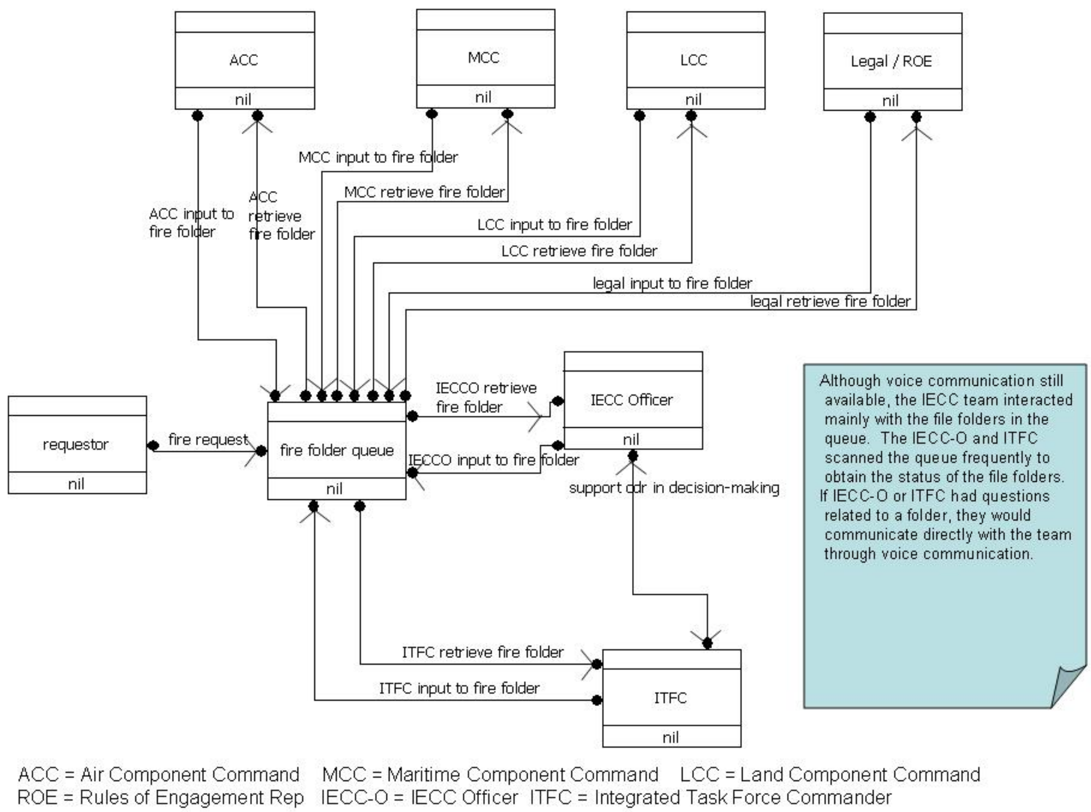

Figure 6 Simplified Operational Nodes Connectivity for Decentralized C2 with Specialists

Model 4 : Decentralized Control with All-capable Entities

- **Parallel Task Processing and Collaboration** – This model assumed that the IECC was made up of a group of all-capable entities. An entity could be a person or a unit that are trained to handle all the tasks in the targeting process, and that they have the necessary authority to take action throughout the process. They share the same understanding of the commander's intent and the same situation awareness. No traditional commander role existed in this model. All open requests were stored in a queue and entity would choose a folder from this queue to process. While each fire folder was processed sequentially (i.e. going through the targeting process on step at a time) by one entity, multiple fire folders were being processed at the same time. Collaboration and Synchronization were expected, especially when dealing with limited resources to fill the requests. Nonetheless, little collaborations and synchronization were observed, and the wargame was turned into a competition of who could process the most fire folders. In fact, due to the novelty of this C2 model, the experiment planning, infrastructure setup, participants were not prepared to deal with many issues related to this model. Yet, since our goal was to explore rather than to measure, the ability to role-play with realistic tools allowed the participants to identify critical issues and imagine the possibility that could be developed from this model.

- **Situation Awareness** – No participants complained about lack of SA to do their job.
- **Allocation of tasks** – Not applicable

Understanding the assumptions we used in this model are subject to debate, we have gathered the following points of discussion:

- **Redundancy** – as observed from the experiment, redundancy ensured a smooth operation as one of the workstation failed unexpectedly and another entity picked up the work automatically without being prompted (fire folders stayed open for processing on the fire folder queue).
- **Human Resource Requirement** – In all the other models, the minimum number of staff in IECC was determined by the number of specialists needed by the process. In our experiment, the first three models required at least five people to man the IECC regardless of the size and the complexity of the mission. In this last model, the number of entities would likely be determined by other factors such as the size and the complexity of the mission.
- **Prioritization and Quality Control -** this model will require more studies on how to maintain priority and quality control so that entities would not turn the mission into a competition for quantity of requests filled.

Figure 7 illustrates the main connectivity and information exchange between operational nodes in this model.

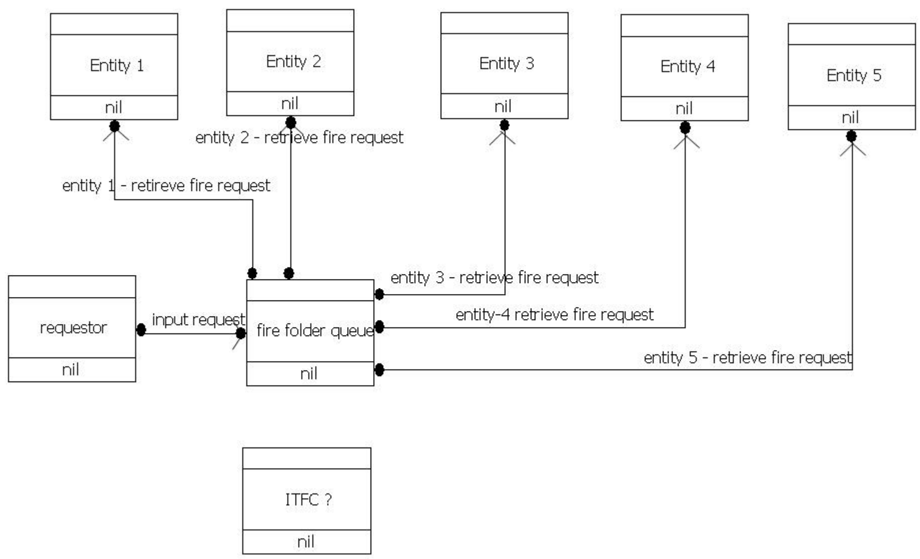

Figure 7 Simplified Operational Nodes Connectivity for Decentralized C2 with All-capable Entities

4.2 Lessons learned from Experiment Preparation

This experiment presented a unique set of challenges. The main and sub objectives for this experiment required a reasonable level of infrastructure and role player expertise. However, due to our limited resources and experience in conducting an enhanced tabletop experiment, we have faced various challenges. Also the level of expertise required for role players was not fully understood. After completing IECC we have a much better understanding of experiment infrastructure and preparation requirements.

Role-players - In order to properly explore candidate topologies it is important that the role-players participation is consistent and they have a good understanding of:

- the concept,
- military team interaction,
- command structure, and
- that all the role-player should have the appropriate level of operational experience;

Situation Awareness - It is imperative that the roles players are given a good level of battle space SA and visualization. Operational and resource data must also be made readily available (visual display or stateboard). Without this level of realism role-players were not able to conduct collaborative planning or maintain any degree of battle rhythm.

Information Sharing Forms - The information sharing forms developed for the IECCEX met minimum requirements subsequent to some adjustments made after day 1 of the experiment. It is important that the role-players focus on planning and execution and not have to deal with technical issues;

Scenario - The scenario that is used to support an experiment must be of sufficient fidelity to meet experiment objective requirements. It must also offer opportunities to measure and observe key performance parameters when specified.

ORBAT/Supporting Forces - If knowledgeable and experienced roles players are employed it is imperative that the ORBAT/forces support the scenario and that they meet experiment objective requirements. However, the ORBAT must also challenge the role players to optimize usage of available resources, therefore, a control process must be in place that indicates which assets have been tasked and which assets are available;

Rules of Engagement - ROE has become an essential element of all military operations, therefore, experienced role players will have a good understanding of ROE. While it is important that ROE does not become all consuming and the focal point of the experiment, it is also important that it is sufficiently robust to meet the requirements of the experiment and add a level of realism.

White Cell - It is essential that the white cell staff have a good knowledge of the operations that will be conducted in order to meet the objectives of the experiment. It is also important that new challenges/information be introduced into the experiment at a frequency that will maintain battle rhythm without over stressing the infrastructure and role players.

Analysis and Data Collection - It is imperative to understand the scope and objective of the experiment and its intention. Further, it is important to understand the analysis and data collection limitation of the infrastructure, personnel and experiment control. If the experiment is designed to prove/disprove a hypothesis or validate a concept a high level of scientific rigor is required. If the experiment is exploratory, such as the IECCEX, then a lesser level of scientific rigor is acceptable. However, an exploratory experiment is designed only to explore and further refine options (although it provides partial evidences for or against some beliefs or hypotheses) and not to prove/disprove or validate options or concepts.

5 Conclusion

The IECCEX yielded a good level of understanding of the process flow and control models and the associated pros and cons. Valuable insight was gained into the information and situational awareness expectations as well as areas best suited to automation for each model. Finally, infrastructure (hardware/software), preparation and personnel requirements necessary to meet experiment objectives were also identified. The findings and lessons-learned will be incorporated into subsequent concept development activities to formulate the future JFS model.

References

[1] Babcock, S. (2006). A DND/CF Concept Paper and Roadmap for Network Enabled Operations, (DRDC TR 2006-01). Defence R&D Canada.

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Annex A Additional Information used in IECCEX

A.1 ROE used in IECCEX

- Damage to national infrastructure is to be minimized
- Deadly force is authorized for force protection
- Non-Deadly force is authorized to defend property
- Non-Deadly force is authorized to restore order from civil disturbances
- Any operations, other than force protection, which would result in damage to hospitals, schools and religious buildings, are not authorized

A.2 Friendly ORBAT

Friendly ORBAT				
Weapons System	**Ammunition**	**Range**	**Fire Inhibit Zone**	**Remarks**
2 x Batteries of M777	155 - HE	25 Kms	200 Meters	Max Range
	Excalibur	65 Kms	200 Meters	Max Range
2 x MBT troop 4 MBT / troop	HE	5 Kms	100 Meters	Max Range
1 x LAV platoon 4 LAVs	25 MM - HE	3 Kms	100 Meters	Max Range
	7.62 MM	1800 Meters	50 Meters	Max Range
1 x COBRA Flt-AH 2 AH / Flt	Joint Common Missile (JCM)	15 Kms	500 Meters	Max Range
1 x COBRA Flt-AH 2 AH / Flt	30 MM - HE	4 Kms	300 Meters	Max Range
1 x CAP 2 x CF18	JCM	25 Kms	200 Meters	Max Range
	25 MM - HE	3 Kms	500 Meters	Max Range
1 x Naval Task Unit 2 x CPF / TU	Harpoon Blk 2 - Land Attack	120 Kms	1Km	Max Range
	5 Inch gun - HE-ICM	16 Kms	200 Meters	Max Range

A.3 Enemy ORBAT

Enemy ORBAT			
30 x APC	12.5 MM	2.5 Kms	Max Range
10 x Jeeps	106 MM	600 Meters	Max Range
8 x Dismounted Mortars	81 MM	1.5 Kms	Max Range

A.4 Friendly Forces

Friendly Forces	
1 dismounted Battalion	4 companies - 126 Pers / company
9 x dismounted sections	10 pers / section
6 x SOF teams	2 Man

A.5 Enemy Forces

Enemy Forces	
3 Companies Mechanized Infantry	80 Pers / Company = 240
1 dismounted Battalion	3 companies / Battalion
27 Sections	12 pers / section
10 x Militia Fire Teams	6 pers / fire team

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The first exploratory experiment of the Joint Fire Support (JFS) Technology Demonstration Project (TDP), the Integrated Effects Coordination Cell Exploratory Experiment (IECCEX) was conducted by the Canadian Forces Experimentation Center (CFEC) Effective Engagement Team (EET) and JFS TDP in the Joint Concept Laboratory and Training Center (JCLTC) located in CFEC, from 14th to 18th May 2007. The main objective of this experiment was to explore various Integrated Effects Coordination Cell (IECC) manning, process flow and control models in order to facilitate the identification of an appropriate model that best suits the requirements of providing optimal Integrated Effects (IE).

In addition to the overall objective the scientific staff also gained valuable insight into:

- information requirements for each option;
- situational awareness requirements for each option; and
- areas best suited for automation.

This report documents the approach used to conduct this experiment and captures the findings and lessons learned.

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